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Approved by:

Carol Rice

James Lockey

Evaluation of Job Changes Within the Refractory Ceramic Fiber Industry and How They Affect an Employee's Occupational Exposures

A thesis submitted to the

Division of Graduate Studies and Research
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In partial fulfillment of the
requirements for the degree of

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1998

by

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ABSTRACT

Knowing the comprehensive history of a job or an employee's occupational exposure is important for determining worker exposures. Changes associated with jobs or job tasks can impact these exposures significantly. Often job descriptions are too general or are inadequate for determining a worker's true occupational exposure history. Collection of detailed task information may be helpful for categorizing worker exposures.

This study used data collected annually by personal interview with individual employees between the years of 1988 and 1993 at three separate Refractory Ceramic Fiber (RCF) plants. Initially, over 350 Current Employee Questionnaire (CEQ) interviews were evaluated and compiled on a computerized spreadsheet. Tasks were listed for each job title, year, and frequency reported from the interviews and cross-referenced to individual workers. To reduce inter-individual variability, only those interviews for which an individual worker was questioned for two or more years and did not change job titles were used. This reduced the number of CEQ interviews to 69.

A sign test was used to evaluate three situations: whether job tasks change over time when compared to the previous interview, the total number of task matches when compared to the previous interview, and regardless of frequency reported, the total number of task matches for one, two and three years. Statistical evaluation of the first situation showed the results for daily, additional daily, weekly/monthly and non-routine task frequencies at all plants were significantly greater than zero ($p<0.0001$, standard deviation = 0.5). For the second situation the results were significantly different from zero at plant A ($p<0.0001$ for daily, 0.001 for additional daily, 0.0001 for weekly/monthly, and 0.0001 for non-routine), at plant B ($p<0.0001$ for daily, 0.0002 for additional daily, 0.0078 for weekly/monthly, and 0.0156 for non-routine) and at plant C ($p<0.0001$ for daily, additional daily, weekly/monthly, and non-routine). In the third situation, results varied since there

was insufficient three-year data for two of the three plants. Tasks that were performed for one year ($p<0.0001$, mean = 3 for all three plants) and two years ($p<0.0001$, mean = 3 for all three plants) were significantly greater than zero. However, data for tasks performed for three years was not significant for Plant A ($n=5$, $p = 0.0625$, mean = 3) and significantly greater than zero for Plant C ($n=13$, $p = 0.0002$, mean = 2).

The CEQ data was useful in evaluating whether job tasks change over time. Underlying reasons for task changes are possibly related to the fact that some tasks are only performed for a short period of time, workers rotate and fill in for other employees on occasion, or incomplete reporting by the employees due to recall bias. When evaluating the task matches independent of frequency reported, we see that the frequency of reporting tasks can increase the number of task matches between interview years.

Air monitoring data showed that exposures remain relatively constant, despite the associated changes in job tasks. This could be a result of the documented limitations of NIOSH method 7400, or simply the fact that the changes that occur to the job tasks are minor when compared to the routine tasks that are performed within a particular job title. Also important to note is that the data evaluated was representative of average exposures within a specific job title for the individual plants.

Results indicate that job tasks change over time, however further investigation into this matter must be made before definite conclusions can be made concerning the long-term impact on daily exposure measurements.

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to the members of my committee; Dr. Carol H. Rice, Dr. James E. Lockey, and Dr. Peter S. Gartside in helping me successfully complete this thesis. Special thanks goes to Dr. Rice for her continual encouragement and support throughout this process, and for constantly reminding me that I did not need to solve the problems of the world.

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CHAPTER ONE – INTRODUCTION

1.1 THE REFRACTORY CERAMIC FIBER INDUSTRY

Production of Refractory Ceramic Fibers (RCF) began in the early 1940s; RCF was used in jet engines manufactured during World War II (Kirk-Othmer, 1982). Extensive production of RCF did not occur until the 1970s, about the time that the general public was becoming aware of the health hazards associated with asbestos-containing materials. Health hazards associated with asbestos were documented as early as the 1930s and include pleural plaques, pulmonary fibrosis (asbestosis), lung cancer, and mesothelioma (Harrington and Saracci, 1994). While the increase in production of RCF can be attributed to the decline in use of asbestos materials, another contributing factor was that the RCF production process had improved which allowed RCF to be available at a lower cost. A demanding public desiring protection of workers, along with the added benefit to employers of having RCF available at a lower cost, made the substitution of RCF for asbestos acceptable.

Refractory ceramic fibers are Man-made Vitreous Fibers (MMVF), with stability at temperatures generally above 1093 degrees Centigrade (Kirk-Othmer, 1982). Oxide fibers are formed from alumina, silica, kaolin clay and added metal oxides. These fibers have diameters in the range of 0.5 – 10 micrometers, and their length ranges from 1 centimeter to continuous filaments (Kirk-Othmer, 1982). Oxide fibers are manufactured into a loose wool, then later needled, pressed, vacuum-formed or fabricated into other shapes. Today it is thought that over 225,000 U.S. workers are exposed to MMVF (including fiberglass, mineral wool and RCF) during manufacturing and end-use application of these materials (US DOL, 1997). An estimated quantity of domestic production of RCF in the early 1990's was 85.7 million pounds (TIMA, 1990), however based upon quantities produced in the middle 1990s, the annual amount has increased to 111 million pounds (Lentz, 1997).

There is a broad interest in the possible health hazards associated with the MMVF industry. Officials of the Occupational Safety and Health Administration (OSHA) feel the risks of lung cancer and other adverse respiratory effects are significant, and as a result are developing an action plan to reduce worker exposures (US DOL, 1997). The International Agency for Research on Cancer has classified glasswool, rockwool, slagwool, and refractory ceramic fibers as "possibly carcinogenic to humans" (WHO, 1988). The Environmental Protection Agency (EPA) has determined that RCF may present a significant cancer risk and in 1993, signed a consent order with the three primary RCF producers to provide RCF workplace exposure monitoring data to the EPA (US DOL, 1997). The University of Cincinnati is currently involved in a prospective morbidity study to evaluate the possible respiratory effects associated with RCF at several manufacturing facilities across the United States.

1.2 THE REFRACTORY CERAMIC FIBER PRODUCTION PROCESS

The process of manufacturing RCF is common among all manufacturers, with minor differences dependent upon the items produced and equipment available at the plant. Two of the main differences are fiber size and purity. Raw material mixtures commonly used include alumina-silica, silica-kaolin clay and silica-alumina-zirconia.

Fusing the raw materials in a high temperature furnace to the desired specifications makes RCF. The raw materials are chosen based upon the requirements of the customer and the materials that will be formed. The furnace heats these raw materials to their molten form and then discharges the material through a temperature-controlled opening underneath the tank. This material then goes to the fiberizing unit where it is transformed into fibers by either a steam-blowing process or centrifugal attenuation.

1.2.1 Fiber Blanket Production

The main use of RCF is to make flexible needled blankets. Approximately 60 percent of the RCF manufactured is for this purpose (Kirk-Othmer, 1982). Fibers are first sprayed with lubricating oil while still inside the fiberization unit holder, and then they are directed to a conveyor belt. The conveyor transports the fiber through compression rolls to form the blanket shape. Once formed, a needle board is used to help tie the fibers together and then interlock the blanket. When the needling process is complete, the blanket is compressed again, then enters a high temperature furnace that allows the oil to be burned off, and helps to increase the tensile strength of the RCF material. The final step is to cut the blanket to a particular size, and then roll it and package it for the customer. The packages are loaded onto pallets and then taken to the shipping area. Figure 1.1 depicts the blanket line process.

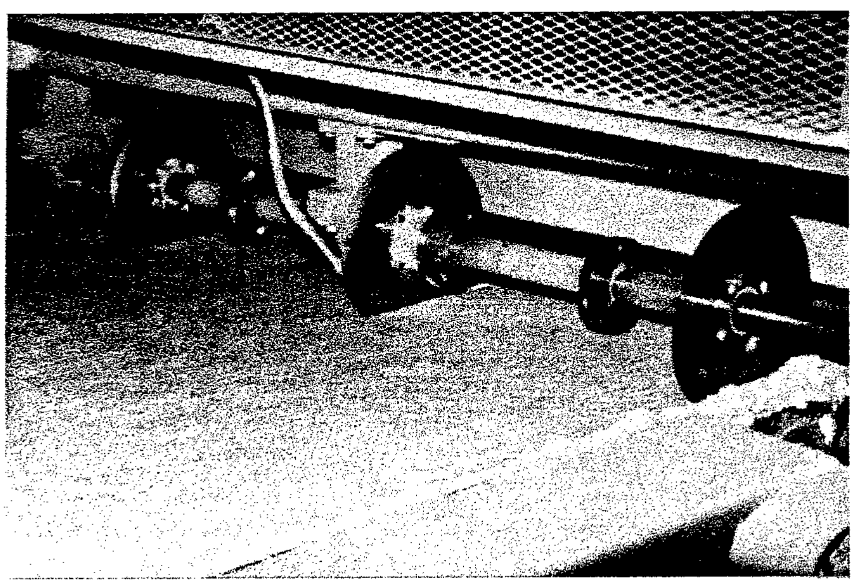

Figure 1.1 Blanket Line

The blanket production process employs about six people per line. They are made up of one employee that monitors the furnace and fiberization process, one needler, two employees at the end of the line and a forklift driver. There is also a shift supervisor that rotates among the sections and monitors the entire production process.

1.2.2 Bulk Fiber Production

The same heated process forms bulk fiber, however no oil is added in the fiberization unit container. The material is in its final stage once formed, and is simply packaged for transport from this point forward. The bulk fiber is either bagged or baled in the packaging area. The bulk fiber is sold as a finished product or used as a general purpose filler for expansion joints, as stuffing wool, for furnace and oven construction, in steel mills and aluminum and brass foundries, or as a raw material for production of vacuum-formed shapes (Kirk-Othmer, 1982). Since the manufacture of the bulk fiber is a relatively simple process, the bulk fiber lines usually employ only two workers, one for tending the furnace and the other to do the packaging. Figure 1.2 shows some scrap bulk fiber.

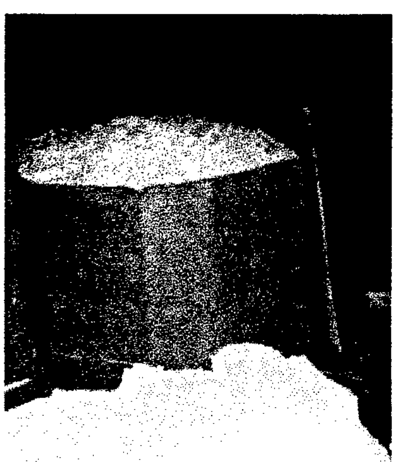

Figure 1.2 Bulk RCF Fiber (Scrap)

1.2.3 Vacuum Cast Products

Vacuum-formed shapes comprise about 20 percent of the products that are made from RCF. Combining bulk fiber with water, clays, organic binders, and other raw materials makes vacuum-formed shapes. The materials are placed into a large mixing tank and then combined to form a slurry. Figure 1.3 shows a RCF worker adding raw materials to make the vacuum cast slurry. A mold with a fine-mesh screen surface is then inserted into the slurry and filled. A vacuum that molds the fibers to the cast pulls the water through the screen. Once all the water is removed from the cast by the vacuum, the cast is moved to a drying rack. The drying rack is inserted into a drying oven where it is dried at temperatures of approximately 100 – 200°C (Kirk-Othmer, 1982). Once dry, the now rigid fiber cast is transported to the finishing area where it is cut and smoothed using various power and hand operated tools. Figure 1.4 shows a RCF worker whom is drilling holes in the finished vacuum cast product. The largest use of vacuum-formed products is the lightweight board insulation, which is used for furnace linings. Both the production and finishing sections of the vacuum cast area employ two workers, depending on current workload demands.

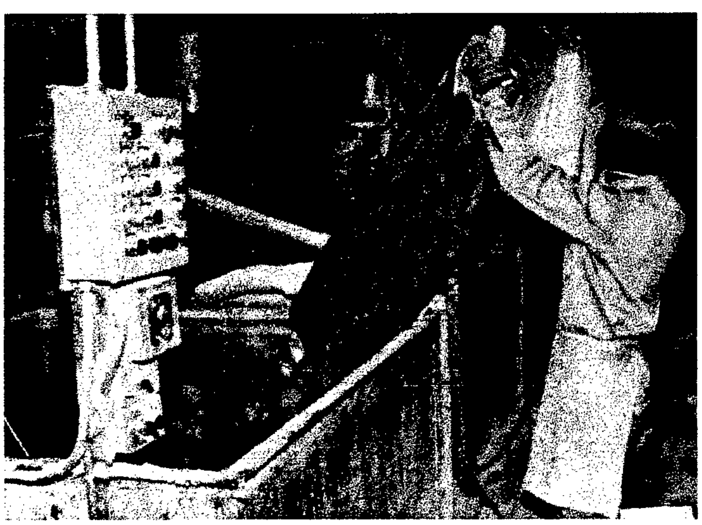

Figure 1.3 Making Vacuum Cast Slurry

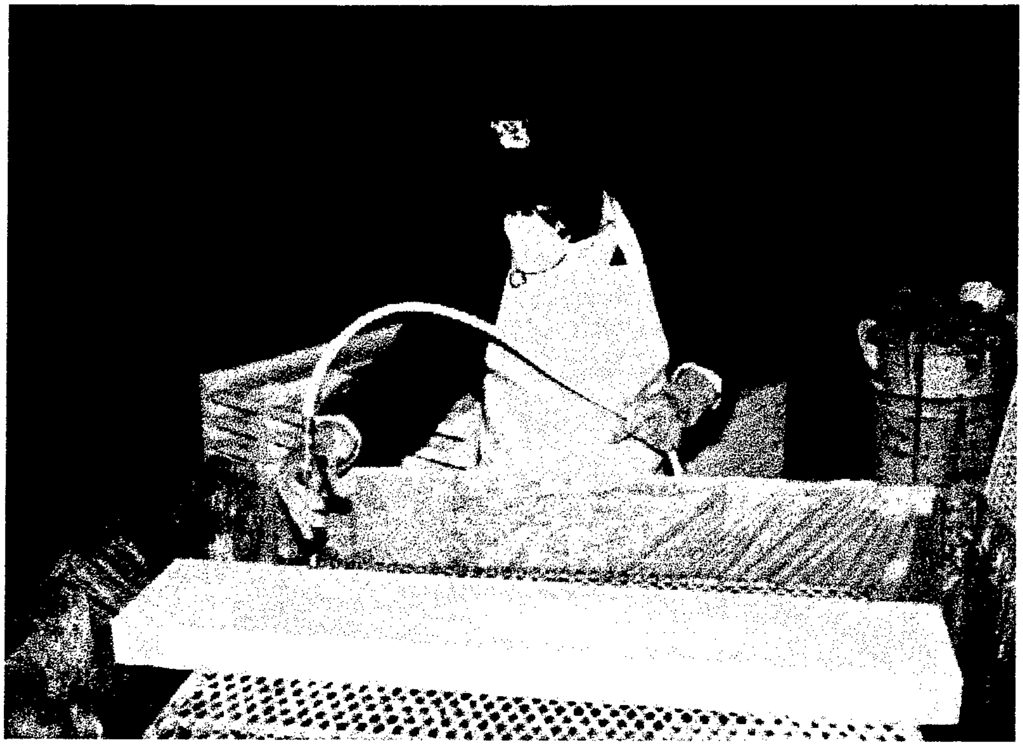

Figure 1.4 Drilling Holes in Vacuum Cast RCF

1.2.4 Module Assembly

To make modules, RCF blanket is cut and stacked or folded in an accordion-like fashion and then bound together to form a block. Either the folding or stacking procedure may be done pneumatically or manually. Figure 1.5 shows women manually making modules. Metallic hardware is attached to the block as it is folded and compressed and is later used during installation to attach the materials to the structure. This hardware attachment reduces installation time and labor and subsequently has made it a popular product that is preferred over layered blanket construction (Kirk-Othmer, 1982). Module assembly is a component of the special products job title, so the number of employees varies, based upon production needs.

Figure 1.5 Making Modules

1.2.5 Textiles

The refractory ceramic fibers can be twisted into yarns and woven into fabrics. Running the bulk RCF through a carding machine and other machinery to form the thread produces these textiles. The materials are often mixed with special coatings like Teflon (Kirk-Othmer, 1982), before being woven into fabric. The fabric is used to produce heat-resistant clothing, flame curtains for furnace openings, and other types of insulating products. Figure 1.6 shows the fabric weaving process.

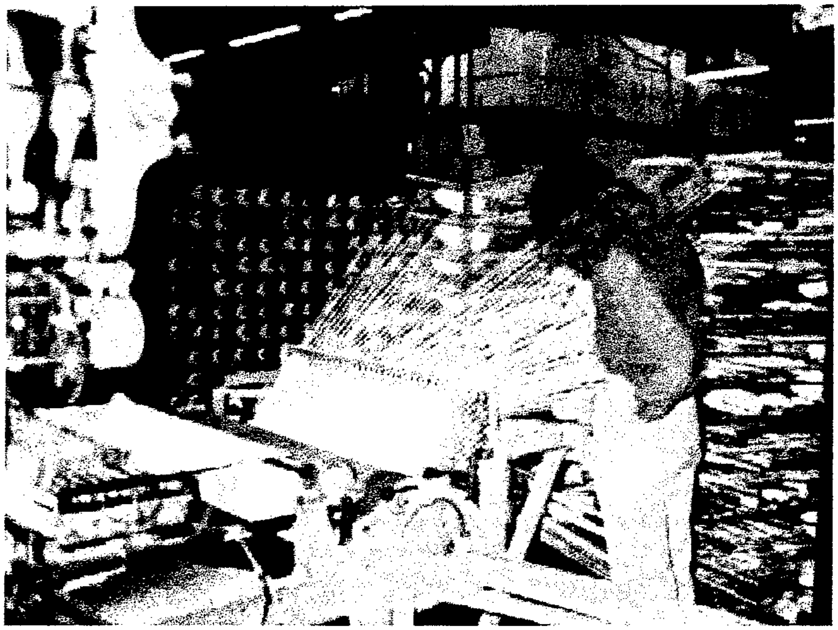

Figure 1.6 Weaving Process

These fibers are also produced into rope materials of various diameters. Cutting the RCF blanket, compressing it and then braiding it with fiberglass yarn can also be used to form RCF rope. Figure 1.7 shows a RCF worker making rope.

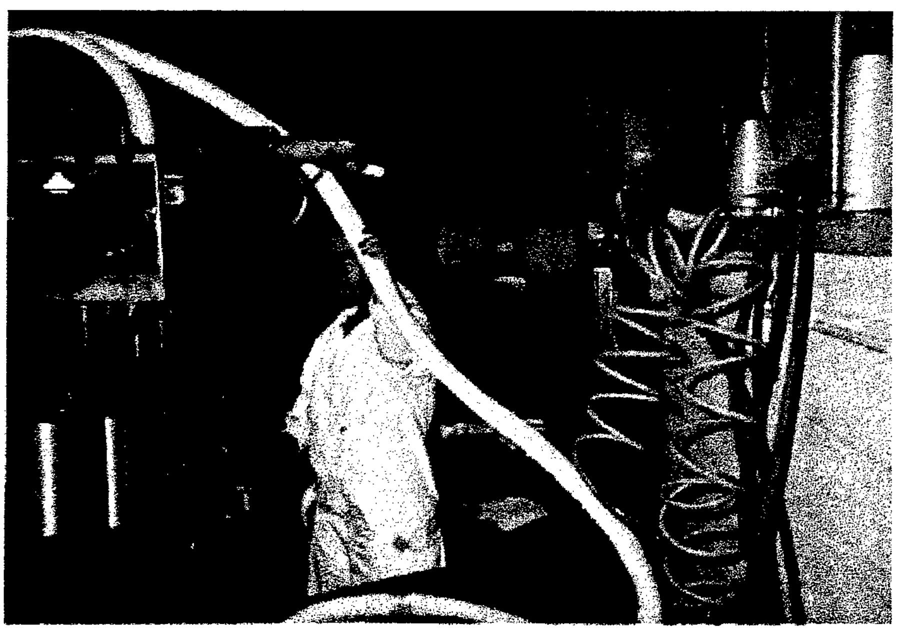

Figure 1.7. Making Rope

1.2.6 Special Products

In addition to the products listed above, RCF is used to make die-cut products and felts. These products are made depending upon the needs and specifications of the customer.

Cutting the RCF blanket into specific shapes using a rotating die-cutting block makes die-cut products. The largest application of these products is in the automobile industry as thermal insulation for catalytic converters (Hughes, 1991).

Mixing bulk RCF with organic binders, normally phenolic resin, makes felts. Once mixed, the fiber is then passed through an oven at a constant pressure to form high-density felts. These felts are commonly used in the steel foundries as ingot-mold insulators (Kirk-Othmer, 1982).

1.3 REFRACTORY CERAMIC FIBER TOXICOLOGICAL INFORMATION

The chemical and physical characteristics of MMVF provide a basis to believe that some types of fibers may persist in the body long enough to produce adverse pulmonary health effects. Research into the effects of RCF on humans is in the early stages because of the latency period of the fibers causing effects on the body. However, there are some initial reports available on this, and there have also been several animal studies performed to evaluate the long-term effects of RCF in vivo.

1.3.1 Animal Studies

Data obtained from the various animal studies have shown some inconsistencies; some have demonstrated pulmonary effects while others indicate no adverse effects (WHO, 1988). The studies that have shown effects have also noted certain chemical and physical characteristics of the fiber that may play a role (WHO, 1988). Its length to width aspect ratio determines fiber deposition in the lungs, and fiber persistence is a function of its chemical composition.

Davis et al. (1984) exposed 48 Wistar rats to concentrations of 10 milligrams per cubic meter of respirable ceramic fiber dust for seven hours a day, five days a week for one year. They observed seven malignant pulmonary neoplasms and one benign adenoma.

Smith et al. (1987) exposed Osborne-Mendel rats and Syrian golden hamsters by inhalation (nose only) to 10.8 milligrams per cubic meter of refractory ceramic fiber dust for six hours per day, five days a week for two years. The researchers found no respiratory tract tumors, however they did note one statistically insignificant mesothelioma of the lung in one hamster. Also, abdominal mesotheliomas were noted in 24 percent of the rats and 83 percent of the hamsters that were injected intraperitoneally with one 25-milligram dose of RCF.

In two similar studies, male Fischer 344 rats and Syrian golden hamsters were exposed by nose-only inhalation to either HEPA-filtered air (chamber controls) or 220 fibers per cubic centimeter of size-selected RCF fibers for six hours per day, five days per week (Mast, et al., 1995; McConnell, et al., 1995). The Fischer 344 rats were exposed for a total of 24 months, while the Syrian golden hamsters were exposed for a total of 18 months. Researchers reported pulmonary and pleural fibrosis, mesothelioma and lung cancer in the exposed rats, and pleural fibrosis and mesothelioma in the hamsters.

1.3.2 Human Studies

Lockey, et al. (1996) in a nested case-control study evaluated chest radiographs from 652 male and female RCF manufacturing workers. Three situations were evaluated separately to include number of years working in RCF production, number of years since first fiber production job, and cumulative fiber exposure. The researchers found 3.1 percent of the current and former workers had developed pleural plaques, while 12.5 percent of those workers with more than 20 years latency from their first fiber job had plaques, and 26.3 percent of the workers manufacturing RCF for more than 20 years had plaques. The case-control study confirmed the belief that potential past asbestos exposure did not account for these pleural plaques.

Lemasters, et al. (accepted for publication) conducted a pulmonary morbidity study to evaluate the respiratory health of RCF workers. Employees at five plants were administered a questionnaire, occupational history and a pulmonary function test. Workers were grouped into production and non-production categories; non-production workers were those that had no exposure or only minimal exposure to RCF. The researchers controlled for age differences, average time of employment and how many years the worker had smoked. Results of this study showed the prevalence of respiratory symptoms was two to five times higher in production workers than in non-production workers. Again, potential past asbestos exposure was ruled out as a causal reason for these respiratory symptoms.

Lockey, et al. (1998) in a seven-year prospective study evaluated the pulmonary function of 361 male RCF workers to determine the relationship between RCF exposure and changes in pulmonary function. Two situations were evaluated: the number of years in a production job and the worker's cumulative fiber exposure. Statistically significant changes in forced vital capacity were noted for workers employed for more than seven years prior to the first test. However, the researchers noted that there was not a statistically significant association for workers employed after 1980, and attributed this to lower RCF exposure levels since that time (Lockey, et al. 1998).

1.4 THE CURRENT EMPLOYEE QUESTIONNAIRE (CEQ)

Byrd (1990) developed the Current Employee Questionnaire (CEQ) to obtain information by personal interview with employees regarding their job title, individual department, tasks performed on a daily, additional daily, weekly, monthly, and non-routine basis. Additional information was collected on the amount of time spent on the task, and any personal protective equipment worn while performing that task. Similar information was obtained on daily maintenance or clean-up tasks. Finally the CEQ is a tool to evaluate whether the employees job has changed within the past year, and if so, obtain additional information. Informed Consent Statement forms are completed prior to interview with the employee, and information obtained is solely used for the RCF study.

1.5 EXPOSURE ASSESSMENT

Air sampling is used to evaluate a worker's exposure during an entire work shift (normally eight hours). According to the Occupational Safety and Health Administration guidelines (OSHA, 1996), a complete work shift or full shift sampling should not be less than seven hours. Industrial hygienists commonly conduct periodic eight-hour time weighted sampling in the workplace. Unfortunately, samples are not always collected on representative days, nor are all tasks performed on a daily basis. The combination of these factors may over- or under-estimate a worker's exposure. Also, since time weighting is an average of a worker's exposure over time, it may mask short-term peaks obtained during the workday.

Corn and Esmen (1979) used exposure zones to estimate workers' exposures based on the above problems associated with conducting full shift sampling. They divided each facility into dust zones based on similar characteristics such as operations and processes, environment, engineering controls, previous air sampling data, and hazardous agents. Care was taken to ensure that individual workers were not classified in more than one zone.

The investigators collected personal breathing zone air samples from all day shift workers at two manufacturing plants and also collected random samples using the exposure zone classifications. The results from the day shift sampling were compared to the calculated number of samples expected to exceed the exposure criteria from random sampling. They found that the exposure zone results were representative, although slightly overestimated, of the results obtained from the personal breathing zone sampling of the entire day shift. In addition, the investigators were able to determine high exposure areas when using the random sampling method that were not identified using the entire plant sampling strategy (Corn and Esmen, 1979).

Rice, et al. (1997), classified study subjects into Uniform Job Titles (UJTs) based upon data collected from occupational histories and Current Employee Questionnaires. These UJTs refer to a group of workers performing similar tasks within a specific job title. The UJTs were further broken down into dust zones using a protocol similar to that used by Corn and Esmen (1979). These dust zones were assigned and exposure concentrations estimated by using either a walk-through survey or a review of historical records.

Maxim, et al. (1997), identified that fiber concentrations vary with functional job category, and as a result found that it is appropriate to evaluate workers' exposures using estimated numbers of workers in each category.

Each of these studies show that categorization of employees by task performance can enhance the effectiveness of sampling in assessing risk. The use of functional job categories, UJTs and exposure zones may provide a better means of evaluating hazards, planning future surveys, and prioritizing engineering controls.

1.6 RESEARCH OBJECTIVES

Knowledge of the comprehensive history of a job or an employee's occupational exposure is important for determining worker exposures. Changes associated with jobs or job tasks can impact these exposures significantly. Often job descriptions are too general or are inadequate for determining a worker's occupational history. Previous studies have shown that it is helpful to collect detailed task information to categorize worker exposures, (Hughes, 1991). This research incorporates Current Employee Questionnaire (CEQ) information that was obtained from 350 workers at three separate RCF plants. Of these 350 interviews, only those CEQs that showed the same employees were questioned in subsequent years were evaluated. A sample of environmental monitoring data was chosen to evaluate the correlation to the CEQs, to determine if exposures change with associated changes in job tasks.

1.7 THE USE OF INTERVIEWS IN EXPOSURE ASSESSMENT

Over the past few years, many researchers have evaluated the effectiveness of using questionnaires to obtain occupational exposure data. Several of these evaluations are outlined in the paragraphs below.

A validation study was conducted by Baumgarten, et al. (1983), to evaluate the accuracy of occupational histories that were obtained by interview and to look at specifics about the individual interviewed (age, education, socioeconomic status, interviewer and number of jobs reported). The data obtained by interview over two 13-year periods were compared to a government data based pension plan. The agreement between the interview data and the employer's records was found to be good, approximately 82 percent for both periods. The authors point out several possible biases of the study, interviewer bias being the one in particular they felt may have most influenced the results of the study.

Bond, et al. (1988), obtained data in a nested case-control study of lung cancer among a cohort of male workers from a chemical production facility. The study compared telephone interviews with records of work area assignments and industrial hygienist developed exposure profiles. Overall respondent recall of usual and work area assignments was good (70.8 and 48.4 percent, respectively) but recall of chemical or physical exposures was poor (2.6 percent). Some factors that the authors identified that seemed to have influenced the results were recall bias, interviewer bias, and the relationship of the interview respondent to the worker (as some were deceased). Bond, et al. (1988), concluded that because of biases and misclassifications inherent to questionnaire obtained data, caution should be used when interpreting the results.

Larsen and Skotte (1991), as a preliminary to a case-control study on the teratogenic hazards associated with short-wave radiation compared the assessment of electromagnetic radiation exposures based on direct measurements and observations to data collected during interviews with female workers. Measurements were obtained throughout one day in nine clinics. Electric and magnetic field strengths were measured and hazard zones were calculated. Telephone interviews were conducted to obtain information on the equipment used that day, the time of the exposure to and the distance away from the source. Exposure calculations were also performed based upon the information reported. Statistics were used to compare the results of the direct measurements to the telephone interviews. The researchers concluded that this method provided a rough assessment of peak and whole-day exposures to electromagnetic radiation.

Rosenberg (1993), as part of a cohort study, evaluated the reproducibility of self-reported occupational histories for 326 workers exposed to polychlorinated biphenyls (PCBs). The study compared two sets of interviews, taken three years apart, to determine if this method of obtaining occupational histories was reliable. In general, he found the results to be highly reliable in assessing cumulative exposure to PCBs.

Frank and Balk (1993) recommended an exposure history be collected to aid in the diagnosis of disease. A complete exposure history should consist of three parts: exposure survey to include exposure and work site health and safety information; work history with a complete description of current and previous employment; and an environmental history which provides information about the worker's non-occupational exposures related to his home environment. The reasoning is that collection of a complete exposure history takes only minutes, however the benefits can aid in diagnosis and proper treatment of the patient.

Teschke, et al. (1994), used two separate questionnaire formats to obtain exposure data on a group of saw maintenance tradesmen. The two questionnaires, one open-ended and the other with partly prompted and detailed questions, provided different responses from the participants. The open-ended one gave less information overall, but the information that was obtained included exposures to agents not listed on the detailed questionnaire. For both types of questionnaires, sensitivity and specificity were low. However it also showed that detailed prompting improved sensitivity with less impact to specificity than did partial prompting. Concluding, Teschke, et al. (1994), suggest that selection of the type of questionnaire to use should be based on the particular needs of the situation.

Fritschi, et al. (1996), used a large case-control study to compare self-assessed to expert assessed occupational exposures. Subjects were asked via a postal questionnaire to provide their employment history and whether they had been exposed to any of 13 substances listed on the questionnaire. A few days later a study member visited the worker and an in-depth personal interview was conducted. These interviews were forwarded to a team of industrial hygienists and chemists to assess the reported exposures and determine their validity. Specificity of the self-assessment was high, however sensitivity was low. The authors concluded that self-assessment of occupational exposures did not prove accurate enough to rely on them as a sole means of exposure assessment.

Blatter, et al. (1997), compared the differences of obtaining information on occupational exposures to pregnant women by a postal questionnaire and by personal interview. Data obtained were tested for agreement using a Kappa statistic and corrected for chance. The authors found that the responses from the postal questionnaire tended to over-report workplace exposures when compared to responses given during personal interview. Because of the high potential for misclassification, the authors concluded that self reported information is not a suitable substitute for job and task specific interviews.

Campbell, et al. (1997) conducted a validation study to assess the quality of self-reported occupational activities using a structured questionnaire. A total of 152 employees were interviewed to obtain work-related physical task data. A sample of this population was randomly selected, and the interviewers observed and documented the workers' activities during a typical shift. The questionnaire and observation data were compared to evaluate agreement. Campbell, et al. (1997) found that for most activities there was good agreement, however, they concluded that the questionnaire did not allow detailed quantification of work tasks.

Rice, et al. (accepted for publication), identified a new approach to determining bystander exposures. They used maps of process buildings, storage sites, and disposal locations to help trigger construction workers (carpenters) memories to aid in developing individual worker exposure histories. This technique was effective in helping the workers recall where they worked, even if they held multiple jobs. The authors concluded that by linking work reported to the workplace history, identification of past occupational exposures might be made.

These studies all had different results, a fact inherent to questionnaire surveys. While they provide a means of collecting occupational data, they should be used with caution and the researcher should be aware of the potential for variability in their results. Overall, though, people tend to know where they work, but not with what they work.

CHAPTER 2 – RESEARCH METHODOLOGY

2.1 THE CURRENT EMPLOYEE QUESTIONNAIRE (CEQ)

2.1.1 Administration of the Current Employee Questionnaire

The CEQ was administered annually to collect job information that might not be normally reported during a typical industrial hygiene survey. Interviewers were trained in the proper methods of administering the CEQ under supervision of the Industrial Hygienist in charge of this project. This training was designed to familiarize the interviewers with the CEQ and prepare them for questions that may arise during the interview.

The interviewer coordinated with plant personnel prior to arrival at the plant, and upon arrival, informed management of the procedures and reasons for conducting the CEQ. The interviews were conducted at the plant facilities, either in the manufacturing area or in an office area adjacent to this area.

The steps followed in administering the CEQ are as follows:

1. The interviewer used the CEQ form to read a standardized paragraph of introduction.

   This introductory paragraph explains the purpose of the survey, the data to be collected, and that the employees' information will be kept confidential. If the employees had not been previously interviewed, they were informed about the necessity of the survey, and asked to complete an Informed Consent form. The interviewer explained that the information collected would be confidential, and they had the right to withdraw from the survey at anytime. The interviewer then answered any questions the employees had concerning risks or hazards that might arise from answering the questionnaire. The employees then signed the forms, and the interviews continued.

2. The employee is then asked to provide their name and job title. This information is documented on the CEQ.
3. The interviewer then asks the employee to provide a list of tasks performed each day, excluding breaks and lunchtime. Information on the number of hours each task is performed, and the Personal Protective Equipment (PPE) that is used during task performance is also collected.
4. The next question addresses additional cleanup or maintenance tasks that are performed on a daily basis, and also inquires about the duration of the individual tasks and the PPE used. Data on additional tasks (either maintenance, cleanup or other) that are performed on a weekly or monthly basis is collected next. The number of hours for each task, the frequency of performance (weekly, monthly) and the PPE used is obtained from the interviewee.
5. Another question is asked to address the performance of tasks on a less frequent or non-routine basis that may expose the employee to dust or chemicals. Again, data is collected on the number of hours each task takes, the number of times this task was performed over the last year, and the PPE used during the task. An additional question is posed to determine to what the individual was exposed to during this task.
6. The interview concludes with some final questions regarding whether the employee's job title has changed in the past year, and if so, the previous job title is

documented. Questions to obtain further information on the old job title are asked to determine if the old job title still exists, and if the new job title is a new activity at the facility.

Information obtained from the interview is documented on the CEQ, exactly as the interviewer hears it from the employee. A blank copy of the CEQ, the CEQ Documentation and Specifications are illustrated in Appendix A.

2.1.2 Data Collected Using the CEQ

Data was collected annually by personal interview with individual employees. This study used data collected between the years of 1988 and 1993 at three separate RCF plants. The interview years evaluated at each plant were as follows:

Plant A	1989, 1990, 1992
Plant B	1988, 1989, and 1990
Plant C	1989, 1991, 1993

Initially, over 350 CEQ interviews were evaluated and compiled on a computerized spreadsheet. Tasks were listed for each job title, year, and frequency reported from the interviews and cross-referenced to individual workers. Task frequencies included daily, additional daily, weekly/monthly, and non-routine. After a review of these data was completed, a determination was made to use only those interviews for which an individual worker was questioned for two or more years and did not change job titles. The reason to do so was to reduce differences that may be caused by inter-individual variability. For example, one individual might remember performing tasks A, B, C, and D one year, and while these same tasks were still performed in subsequent years, the comparison individual might not remember the same tasks and might report only a few, more or different tasks than originally reported. Individual differences could also be a function of how important an individual believes a task to be, or if they consider it an integral part of another task. For example, delivering supplies may not be possible without the use of a forklift, and when listing tasks this worker should report that they deliver supplies and drive the forklift. However, one individual may report both tasks, while the other, thinking that driving the forklift is an integral part of delivering supplies, might only report one task, that of delivering supplies. Comparisons made for only those individuals that were interviewed for more than two years were thought to have reduced this inter-individual variability. This reduced the number of CEQ interviews to 69. These data were thought to best represent the interview population, as the original selection of workers interviewed was chosen based upon who was available at the day and time of the interview sessions, not by job title.

2.1.3 Task Comparison

Individual tasks reported by workers were grouped into more general categories. Categorization was done to provide some consistency and eliminate individual task description variability. Because the CEQ is an open-ended questionnaire, it was expected that each individual would report the same tasks differently or by different names. The task groupings were created to reduce this inter-individual variability.

The task groupings were also created to reduce the number of reported tasks to a manageable number, however significant effort was made to keep like exposures together. For example, *clean up with an air hose* was grouped separately from *cleanup* and *clean with chemicals* based upon the idea that each task classification would represent the potential differences in worker exposures during performance of these tasks. In this case the first job task would produce potentially higher exposures to RCF than the second, and the last would produce mainly a chemical, not a fiber, exposure.

Once the three plants' tasks were classified and grouped, a list was developed and reviewed by Drs. Rice and Lockey of the University of Cincinnati. Also, those reported tasks needing clarification were forwarded to the respective RCF plant personnel and clarified. A complete list of these final task classifications is found in Appendix B.

2.1.4 Data Analysis for the Task Comparison

A new spreadsheet was developed for each of the three plants by modifying the original spreadsheets to make data analysis easier. Replacing the individual reported tasks with the respective grouped task classification did this. For Example, "cleanup shop," "end of shift cleanup," and "sweep floor" were all replaced with "cleanup" while "run card machine," "monitor material from card," and "adjust carding machine" were replaced with "operate carding machine."

Spreadsheets were then made to aid in evaluation and manipulation of these data. Three tables were created for each of the three plants, resulting in a total of nine new spreadsheets. This spreadsheet data was then tabulated and loaded into the computerized statistics program SAS (SAS, 1996). The comparisons that were made with the data included task matches with the previous interview, total number of task matches compared to the previous interview, and independent of frequency, the total number of task matches. Examples of each spreadsheet are found in the following paragraphs.

2.1.5 Job Titles Where Tasks Changed Over Time When Compared to the Previous Interview

Each worker's individual tasks were compared to the previous interview to determine if there was a change over that period of time. The null hypothesis was:

The type of tasks performed by an individual does not change from year to year.

A "1" was used to represent a change, a "0" was used to denote no change. Missing information was encoded with an asterisk, "*". An example is provided in Table 2.1. Tests of normality of the distributions of data were performed using the SAS procedures Proc Univariate and Proc Frequency (SAS, 1996). A sign test was used to determine the significance of changes in the individual's job tasks when compared to the previous interview (SAS, 1996).

Table 2.1 Changes in Individual Job Tasks When Compared to the Previous Interview

ORIGINAL DATA												
Plant A	Daily Tasks			Additional Tasks			Wkly/Mnthly Tasks			Non-Routine Tasks		
Job Title	89	90	92	89	90	92	89	90	92	89	90	92
mtce tech	Repair /maintain machinery	Repair /maintain machinery	Repair /maintain machinery	-	cleanup	-	cleanup	-	-	-	clean with chemicals	-
	general mtce	general mtce	general mtce	no	-	no	-	no	no	-	-	Repair /maintain machinery
	welding	-	-							no	-	-
DATA TRANSFORMED FOR STATISTICAL ANALYSIS												
mtce tech	*	0	0	*	1	1	*	1	0	*	1	1
	*	0	0	*	1	1	*	1	0	*	0	1
	*	1	0							*	1	0

\- Indicates that particular task was not reported during that interview.

No Indicates that the worker reported that no tasks within that category were performed.

* Indicates that the information is missing, because there is no previous interview for comparison purposes.

2.1.6 Within Frequency Reported, Job Titles That Have Task Matches Over Time When Compared to the Previous Interview

Data from the previous spreadsheet was compiled to identify the total number of tasks that matched for each worker. The null hypothesis was:

Compared to the previous interview, there are no matches for a particular job title.

A zero indicates no matches, and any number one or greater indicates exactly how many matches there were for that worker within a specific frequency. The data for all workers was totaled in this way and an example of the reworked data from Table 2.1 above is shown below in Table 2.2.

Tests of normality of the distributions of data were performed using the SAS procedures Proc Univariate and Proc Frequency (SAS, 1996). A sign test was used to determine the significance of finding matches within the individual's job tasks when compared to the previous interview (SAS, 1996).

Table 2.2 Total Matches When Compared to the Previous Interview

Plant A	Daily Tasks			Additional Tasks			Wkly/Mnthly Tasks			Non-Routine Tasks		
Job Title	89	90	92	89	90	92	89	90	92	89	90	92
mtce tech	*	2	3	*	0	0	*	0	2	*	1	1

* Indicates that the information is missing because there is no previous interview for comparison.

2.1.7 Independent Of Frequency Reported, Job Titles That Have Task Matches Over Time

Data was compiled to initially combine tasks reported for all frequencies. Then, this data was examined to identify the total number of tasks performed each year, the total tasks performed, and the totals that were reported for each of one, two, and three years. The null hypothesis was:

There are no task matches over time, independent of frequency reported.

A zero indicates no tasks were performed at that frequency, and any number one or greater indicates exactly how many tasks that were reported for that worker within that frequency. For example, if a worker performed the same tasks for three years in a row, this was counted as one match and is shown in the "Total 3 yrs" column. Data is not duplicated among the columns, so if the worker had a task that matched all three years, it was not also counted in the "1 yr" or "2 yr" columns. The end product data for the maintenance technician depicted above was totaled in this way and is shown in Table 2.3 below.

Tests of normality of the distributions of data were performed using the SAS procedures Proc Univariate and Proc Frequency (SAS, 1996). A sign test was used to determine the significance of changes in the individual's job tasks independent of frequency reported (SAS, 1996).

Table 2.3 Independent of Frequency Reported, Total Number of Matches Over Time

Worker #	Tasks Performed			Total Number of Tasks Performed			Totals			Total Tasks
	89	90	92	89	90	92	1 yr	2 yrs	3 yrs	
1	repair/maintain machinery	repair/maintain machinery	repair/maintain machinery	5	5	3	2	1	3	6
	general mtce	general mtce	general mtce							
	Welding	-	-							
	Cleanup	cleanup	-							
	no	no	no							
	-	clean with chemicals	-							

- Indicates that particular task was not reported during that interview.

No Indicates that the worker reported that no tasks within that category were performed.

2.2 EXPOSURE MONITORING

2.2.1 Air Monitoring

Air monitoring was conducted using the Air Sampling Protocol for Fibers and Free Silica. The complete protocol has been described recently by Rice et al., (1997).

2.2.2 Air Sample Analysis

All samples were analyzed according to the procedure described in the National Institute for Occupational Safety and Health: Fibers, Method 7400 (Revisions 3 and 4) in the NIOSH Manual of Analytical Methods (NIOSH, 1994).

2.2.3 Air Sample Quality Control

Quality control procedures for air sampling are described in the Air Sampling Protocol for Fibers and Free Silica. The complete protocol has been described recently by Rice et al., (1997).

2.2.4 Exposure Monitoring Data Analysis

Historical air monitoring results files were reviewed to obtain Time-Weighted Average (TWA) exposure data for any of the 69 employees that had more than one year of exposure data. Eleven employees were found that had monitoring data that met these criteria. Air sampling results were then tabulated by date monitored to determine if exposures had changed along with the changes in job tasks. The null hypothesis was that workers' exposures do not change by task.

An exposure was considered to have changed if there was a difference of greater than 0.25 fibers per cubic centimeter of air (fibers/cc) from the previous air sampling TWA. The 0.25 fibers/cc was chosen because the current RCF industry uses 0.5 fibers/cc as the Occupational

Exposure Limit (OEL), and 0.25 fibers/cc is one-half of that, or what is typically depicted as the action level. A zero represented no change (difference from previous sample is < 0.25 fibers/cc of TWA), and a one represented a change (difference from previous sample is $\geq$ 0.25 fibers/cc of TWA).

Air monitoring results were compared to specific plant averages for each particular job title, in the same monitoring years to ensure the selected data was representative (Rice, 1997; U.C., 1998). Air monitoring data is tabulated and found in Chapter 3, section 3.2, and table 3.15.

CHAPTER 3 – RESULTS

3.1 THE CURRENT EMPLOYEE QUESTIONNAIRE

3.1.1 Administration of the Current Employee Questionnaire

This study used data collected between the years of 1988 and 1993 at three separate refractory ceramic fiber plants. A total of 69 workers' current employee interview data sheets were used. The interview years evaluated at each plant were as follows:

Plant A	1989, 1990, 1992
Plant B	1988, 1989, and 1990
Plant C	1989, 1991, 1993

3.1.2 Evaluation of Data Collected Using the Current Employee Questionnaire

Data from CEQs that had been conducted over a period of two or more years were reviewed and analyzed. A listing of the number of interviews conducted for two years and three years along with the totals for each plant is provided in Table 3.1 below.

Table 3.1 Interview Data Listed by Plant

Plant	Number of People Interviewed		
	2 Interviews	3 Interviews	Totals
A	11	5	16
B	22	0	22
C	18	13	31
Totals	51	18	69

3.1.3 Task Comparison

There were 35 job titles represented from the three plants; 11 for Plant A, ten for Plant B, and 14 for Plant C. While this was not intentional, an approximately equal distribution of interviews was available for each of the three plants. The number of tasks prior to and after consolidation, and the number of workers interviewed for each plant is listed in Table 3.2. Although unintentional, the original tasks for all three plants were each reduced by approximately 81 percent (range 79 – 83 percent) to form the consolidated task list.

Table 3.2 Listing of the Number of Original and Consolidated Tasks by Plant

Plant	No. of Workers Interviewed	Original Tasks	Consolidated Tasks	Percent Reduction
A	16	112	23	79
B	22	145	25	83
C	31	214	39	82
Totals	69	471	87	81 (average)

Appendix B provides the specific task listings for each plant, and breaks them down into the consolidated task list.

3.1.4 Data Analysis for Task Comparison

Drs. Rice and Lockey reviewed the task comparison data using their RCF experience to ensure that consolidations that were made were appropriately classified. The recommended reclassifications by the individuals were small (less than four percent of the total tasks) and the appropriate revisions were made. With some minor exceptions they found the classifications to be consistent with their current knowledge about the RCF industry.

3.1.5 Job Titles Where Tasks Changed Over Time When Compared to the Previous Interview

The tasks were evaluated within specific categories of frequency to determine if they changed when compared to the previous interview. Statistical evaluation of those tasks that were reported as being performed on a daily, additional daily, monthly/weekly and non-routine frequency are outlined below.

3.1.5.1 Daily Tasks

Sign tests performed on these data indicate that the results are significantly different from zero. This is in agreement for all three plants. Referring back to the null hypothesis, this indicates that daily tasks change when compared to the previous interview. Table 3.3 provides a summary of this information.

Table 3.3 Daily Task Changes Compared to the Previous Interview

Plant	Total Number of Tasks Listed	Mean	P-value	Do Tasks Change?
A	85	0.49	0.0001	Yes
B	77	0.61	0.0001	Yes
C	158	0.54	0.0001	Yes

3.1.5.2 Additional Daily Tasks

Sign tests performed on these data indicate that the results are significantly different from zero. This is in agreement for all three plants. Referring back to the null hypothesis, this indicates that additional daily tasks also change when compared to the previous interview. Table 3.4 provides a summary of this information.

Table 3.4 Additional Daily Task Changes Compared to the Previous Interview

Plant	Total Number of Tasks Listed	Mean	P-value	Do Tasks Change?
A	39	0.64	0.0001	Yes
B	37	0.62	0.0001	Yes
C	74	0.47	0.0001	Yes

3.1.5.3 Weekly/Monthly Tasks

Sign tests performed on these data indicate that the results are significantly different from zero. This is in agreement for all three plants. Referring back to the null hypothesis, this indicates that weekly/monthly tasks change when compared to the previous interview. Table 3.5 provides a summary of this information.

Table 3.5 Weekly/Monthly Task Changes Compared to the Previous Interview

Plant	Total Number of Tasks Listed	Mean	P-value	Do Tasks Change?
A	39	0.59	0.0001	Yes
B	49	0.84	0.0001	Yes
C	116	0.70	0.0001	Yes

3.1.5.4 Non-routine Tasks

Sign tests performed on these data indicate that the results are significantly different from zero. This is in agreement for all three plants. Referring back to the null hypothesis, this indicates that non-routine tasks change when compared to the previous interview. Table 3.6 provides a summary of this information.

Table 3.6 Non-routine Task Changes Compared to the Previous Interview

Plant	Total Number of Tasks Listed	Mean	P-value	Do Tasks Change?
A	31	0.45	0.0001	Yes
B	46	0.85	0.0001	Yes
C	100	0.62	0.0001	Yes

3.1.6 Within Frequency Reported, Job Titles That Have Task Matches Over Time When Compared to the Previous Interview

The total number of task matches was compiled from the data collected in the previous spreadsheet. Statistical evaluation of the total task matches that were reported as being performed on a daily, additional daily, monthly/weekly and non-routine frequency are outlined in the tables below. It is clear that daily tasks were generally job specific duties that were reported by the worker, while the additional daily, monthly/weekly and non routine tasks can be generalized into four main categories, none, housekeeping, job specific, and maintenance. The category "none" refers to the fact that the employee reported they performed no tasks within this specific frequency. A breakout of the approximate percentages of the total time these types of duties were reported for each plant and frequency is given in Table 3.7 below.

Table 3.7 Summary of Percent of Total Tasks Reported by Plant and Frequency

Plant	Frequency	None	Housekeeping	Job Specific	Maintenance
A	Additional Daily	44%	53%	0%	2%
	Weekly/Monthly	53%	32%	5%	11%
	Non-Routine	76%	16%	3%	5%
B	Additional Daily	20%	73%	4%	4%
	Weekly/Monthly	31%	14%	48%	5%
	Non-Routine	42%	25%	34%	0%
C	Additional Daily	29%	67%	4%	1%
	Weekly/Monthly	28%	23%	30%	18%
	Non-Routine	52%	6%	29%	13%
Mean	Additional Daily	31%	64%	3%	2%
	Weekly/Monthly	37%	23%	28%	11%
	Non-Routine	57%	16%	22%	6%

3.1.6.1 Total Daily Task Matches When Compared to the Previous Interview

Sign tests performed on these data indicate that the results are significantly different from zero. This is in agreement for all three plants. Referring back to the null hypothesis, this indicates that the same daily tasks are reported when compared to the previous interview. However, on average, the total number of matches is relatively small. Table 3.8 provides a summary of this information.

Table 3.8 Total Daily Task Matches When Compared to the Previous Interview

Plant	Number of Comparisons	Mean	Sign Rank P-value	Number of Matches	
				Minimum	Maximum
A	21	2	0.0001	0	8
B	22	1.4	0.0001	0	4
C	44	1.6	0.0001	0	4

3.1.6.2 Total Additional Daily Task Matches When Compared to the Previous Interview

Sign tests performed on these data indicate that the results are significantly different from zero. This is in agreement for all three plants. Referring back to the null hypothesis, this indicates that the same additional daily tasks are reported when compared to the previous interview. However, the total number of matches is small. Table 3.9 provides a summary of this information.

Table 3.9 Total Additional Daily Task Matches Compared to the Previous Interview

Plant	Number of Comparisons	Mean	Sign Rank P-value	Number of Matches	
				Minimum	Maximum
A	21	0.67	0.0010	0	2
B	22	0.64	0.0002	0	2
C	44	0.89	0.0001	0	2

3.1.6.3 Total Weekly/Monthly Task Matches When Compared to the Previous Interview

Sign tests performed on these data indicate that the results are significantly different from zero. This is in agreement for all three plants. Referring back to the null hypothesis, this indicates that the same weekly/monthly tasks are reported when compared to the previous interview. However, the total number of matches is small. Table 3.10 provides a summary of this information.

Table 3.10 Total Weekly/Monthly Task Matches When Compared to the Previous Interview

Plant	Number of Comparisons	Mean	Sign Rank P-value	Number of Matches	
				Minimum	Maximum
A	21	0.76	0.0001	0	2
B	22	0.36	0.0078	0	1
C	44	0.80	0.0001	0	3

3.1.6.4 Total Non-routine Task Matches When Compared to the Previous Interview

Sign tests performed on these data indicate that the results are significantly different from zero. This is in agreement for all three plants. Referring back to the null hypothesis, this indicates that the same non-routine tasks are reported when compared to the previous interview. However, the total number of matches is small. Table 3.11 provides a summary of this information.

Table 3.11 Total Non-routine Task Matches When Compared to the Previous Interview

Plant	Number of Comparisons	Mean	Sign Rank P-value	Number of Matches	
				Minimum	Maximum
A	21	0.81	0.0001	0	2
B	22	0.32	0.0156	0	1
C	44	0.86	0.0001	0	4

3.1.7 Independent of Frequency Reported, Job Titles That Have Task Matches Over Time

The tasks were evaluated without regard to frequency in which they were reported. For example, data reported for the frequencies of daily, additional daily, weekly/monthly, and non-routine were combined. Statistical evaluation of those tasks that were reported for one, two, and three years are outlined below. Appendix C provides a list of those tasks for Plants A and C that were reported for one, two and three years.

3.1.7.1 Tasks That Were Reported Only One Year

Sign tests performed on these data showed the results to be significantly greater than zero, meaning that almost all personnel reported at least one task only one year. The sign test p-values and the associated minimum and maximum values are reported in Table 3.12. The mean number of tasks reported only once for all plants was three and the median ranged from two to three.

Table 3.12 Tasks Reported Only One Year

		Number of Tasks	
Plant	Sign Test P-value	Minimum	Maximum
A	0.0001	1	8
B	0.0001	0*	9
C	0.0001	0**	7

* One worker reported that no tasks were performed for only one year.

** Two workers reported that no tasks were performed for only one year.

3.1.7.2 Tasks That Were Reported for Two Years

Sign tests performed on these data showed the results to be significantly greater than zero, meaning that almost all personnel reported at least one task that was performed for the two year interval. The sign test p-values and the associated minimum and maximum values are reported in Table 3.13. The mean number of tasks reported twice for all plants was approximately three and the median ranged from two to three.

Table 3.13 Tasks Reported for Two Years

		Number of Tasks	
Plant	Sign Test P-value	Minimum	Maximum
A	0.0001	1	6
B	0.0001	1	7
C	0.0001	0*	6

* One worker reported that no tasks were performed for two years.

3.1.7.3 Tasks That Were Reported for Three Years

Sign tests performed on these data showed varying results. At plant A, the results were not found to be significantly greater than zero, while at plant C they were. We can attribute this to the differences in sample size, Plant A had a sample size of five, while Plant C had a sample size of 13. Plant B had no workers that were interviewed for more than two years while holding the same job title, so no data are available for this plant. The sign test p-values and the associated minimum and maximum values are reported in Table 3.14. The mean and median numbers of tasks reported three times for Plants A and C ranged from two to three.

Table 3.14 Tasks Reported for Three Years

		Number of Tasks	
Plant	Sign Test P-value	Minimum	Maximum
A	0.0625	2	4
B	N/A	N/A	N/A
C	0.0002	1	3

N/A because no workers were interviewed for a total of three years.

3.2 EXPOSURE MONITORING

3.2.1 Exposure Monitoring and Data Analysis

Eleven workers of the 69 total (16 percent), representing seven different job titles, had TWA exposure data available for more than one year. A review of these data show that job exposures do not change significantly when compared with the associated changes in job tasks. One exception occurred, and that was an individual working at Plant C, in the job title "Special Products."

The air monitoring data, when compared to job title plant averages over the same years (Rice, 1997; U. C., unpublished data) are considered representative. There were a few exceptions to this, one involving the same Special Products worker from Plant C whose TWA result was 0.68 fibers/cc above the plant's job title average. The sampling data forms for this worker were reviewed, to discover the possible cause of this excursion. The nature of the job tasks performed that day (cutting four-inch strips of silica/alumina blanket) possibly caused the excursion from the average TWA exposure level. Other exceptions were two shippers and a needler whose exposures were slightly above plant averages on one occasion. Sampling data forms for these workers did not provided the documentation needed to determine why the minor excursions from the averages occurred.

All the air monitoring data evaluated is summarized in Table 3.15 below.

Table 3.15 Exposure Monitoring Results and Evaluation

Plant	Job Title	Worker No.	Date Sampled and TWA Air Sampling Results (fibers/cc)			Difference > 0.25 fibers/cc?	Plant-wide Average for Job Title fibers/cc
A	Braider Operator	12	18-Jun-92 0.03	21-Jun-93 0.03		No	0.09
	Braider Operator	13	18 Jun 92 0.03	16-Feb-94 0.01		No	0.09
B	End of Line B Operator	18	23 Feb 93 0.04	17 Feb 94 0.04		No	0.06
	B OIC Shipping	22	19 Apr 91 0.07	2 Nov 92 0.03		No	0.05
C	Maintenance Mechanic	5	14 Feb 91 0.13	21 Jan 93 0.02	30 Jun 94 0.01	No	0.06 +/- 0.03
	Shipper	7	15 Dec 93 0.01	27 Apr 94 0.13		No	0.05 +/- 0.04
	Shipper	9	18 Sep 92 0.01	14 May 93 0.01		No	0.05 +/- 0.04
	Shipper	10	6 Sep 90 0.01	30 Dec 91 0.25	14 May 93 0.01	No	0.05 +/- 0.04

Table 3.15 Exposure Monitoring Results and Evaluation (con't)

Plant	Job Title	Worker No.	Date Sampled and TWA Air Sampling Results (fibers/cc)			Difference > 0.25 fibers/cc?	Plant-wide Average for Job Title fibers/cc
C	Special Products	14	27 Aug 91 1.49	22 Jan 93 0.33		Yes	0.37+/- 0.44
	Special Products	15	28 Nov 89 0.03	5 Sep 90 0.23		No	0.37+/- 0.44
	Needler	27	13 Dec 90 0.04	30 Mar 92 0.06	23 Jun 92 0.03	No	0.08+/- 0.03
	Needler	27	15 Dec 94 0.19			No	0.08+/- 0.03

CHAPTER 4 - DISCUSSION

4.1 THE CURRENT EMPLOYEE QUESTIONNAIRE

4.1.1 Administration of the Current Employee Questionnaire

Data was not available for all plants during all years. Analyses were performed on the existing data that showed that job tasks change over time. While it would seem that the study's accuracy might have been improved if all employees were interviewed each year, results of the data evaluation indicate this was not an important factor. One would expect that if data was available for each year then analysis might have shown more consistency of duties. However, since on average only one year of data was missing, our results wouldn't be expected to change much, if at all. If data were collected during those missing years, our population sampled may have been larger, giving us a larger sample size.

4.1.2 Evaluation of Data Collected Using the Current Employee Questionnaire

The data available for three years is limited, with the exception of Plant C. Plant B had no employees that were interviewed for three years, while Plant A had only five individuals. If more CEQ data were available for the same employee for the three-year period, the significance test for Plant A might have shown different results.

4.1.3 Task Comparison

While a quota was not established for selection of the number of job titles reviewed at each plant, an even distribution between the plants was seen; approximately 12 at each plant.

The task comparisons consolidated the number of same or similar tasks that were reported differently by each individual worker. This streamlined the evaluation process, and allowed matches to be found that might not have been had they been evaluated as reported by the employee. The consolidations are estimated to have condensed the data by approximately 81 percent.

4.1.4 Data Analysis for Task Comparison

Drs. Rice and Lockey reviewed the task classifications that were made for each plant. Generally, they agreed with the classifications, however a few changes to the task lists were made. For example, at Plant A, *clean office* was reclassified from "Cleanup" to "Administrative," *remove cheeses from the machine* from "Oversee blending system" to "Run former," and the Oil/lubricate Equipment" category was consolidated with the "Repair/maintain machinery" category. The task classifications for plant B were modified to include combining "Monitor furnace" and "Operate furnace," *change, replace, and pickup bad electrodes* were reclassified from "Spinner maintenance" to "Furnace (non-routine op)," *tour plant* was moved from "Trouble shoot problems" to "Administrative," and the "Move raw materials" classification was combined with "Drive Equipment." Changes to Plant C data were minor and included relocating *general clean (dust/sweep)* and *general cleaning* from "General plant cleanup" to "Cleanup," *work in moldables* was moved from "Relieve other employees" to "Make moldable," *change, replace electrodes* was relocated from "Spinner maintenance" to "Monitor/operate furnace," and *chip out furnace* was reclassified from "Furnace maintenance" to "Set up/monitor pot."

Several tasks were difficult for Drs. Rice and Lockey to classify, because when they were reported several key words were left out. These key words would have related the tasks to a specific machine or process. These tasks are annotated with an asterisk to denote that their classifications were guided by the job title. Examples include *lift* and *load machine* which were both reported by an XPE die operator, and as such were classified as "Operate die presses."

4.1.5 Job Titles Where Tasks Changed Over Time When Compared to the Previous Interview

All of the data evaluated showed a similarity between changes in job tasks when compared to the previous interview. Individual workers within a specific job title were evaluated, and as such we would expect to see the greatest amount of consistency in reporting from year to year. Since we did not, we expect the cause to be that tasks do change over time. Especially today, as companies are doing more cross training to increase efficiency and decrease costs.

An evaluation of the data showed that some of the common reasons that tasks change over time is simply because the task is performed one year, then is not the next. Within the additional, weekly/monthly and non-routine frequencies, it was common to see cleanup, maintenance or certain job specific duties performed one interview year, then during the next interview, the employee reported they had no tasks that fit in these categories. The daily tasks commonly showed a job-specific duty performed one interview year and then not the next. This could be because the task was not actually performed that year, or could be a result of incomplete reporting by the employee. Examples of this were found within the interviews of two different card operators, who were interviewed for three years. Neither one of them reported the operation of the carding machine for all three years, nor did they omit its use on the same years. However, if the task comparison groupings are made more generic, then this might change the results of this part of the study, in that it may show that tasks do not change over time. For example, these same card operators each reported that they *oversee the blending system* on those years that they did not report *operate the carding machine*. So, if these two were combined into one grouping, we would have more matches in the three-year time frame.

Another reason for the similarity between task changes is that a task could be reported in one frequency one year, then in another interview, reported as a different frequency. An example is the individual that reported cleanup as a daily task one year, then the next year reported it as an additional task. Future analyses might consider grouping daily and additional tasks together.

4.1.6 Within Frequency Reported, Job Titles That Have Task Matches Over Time When Compared to the Previous Interview

These data indicate that the same tasks are reported over time, however on average, the number of matches were less for additional daily, weekly/monthly, and non-routine tasks than for daily tasks. This indicates that daily tasks are more consistent from year to year than are additional daily, weekly/monthly, and non-routine tasks. Also, the total number of daily tasks reported was generally greater than was reported for the other frequencies. Most frequencies showed a mean value of less than one, with the exception of daily tasks. Again, making it appear that daily tasks are more consistent than are additional daily, weekly/monthly and non-routine tasks.

4.1.7 Independent of Frequency Reported, Job Titles That Have Task Matches Over Time

The minimum and maximum numbers of tasks reported for only one year ranged from one to eight for plant A, zero to nine for Plant B, zero to seven for Plant C, and the mean value for all plants was three. Also, it must be noted that practically every worker reported at least one task for only one year (there were three exceptions). This indicates that tasks do change over time, regardless of frequency reported.

The two year data show that at least one task was performed for two interview years in a row. The minimum and maximum numbers of tasks ranged from one to six for Plant A, one to seven for Plant B, and zero to six for Plant C, with an average of three tasks reported for the two years. Only one worker did not report any tasks that were performed for two years. Since all individuals were interviewed a minimum of two years, and a significantly fewer number of workers were interviewed for three years, we expect the two-year data to show an association.

The three year data showed varying results by plant. Plant A had a sample size equal to five, which is too small to show an association, Plant B had no data for three years, and Plant C had a sample size of 13, which was adequate to show an association. Plant A data was not significant. Plant C data showed that independent of frequency reported, tasks remain the same over time. However, it is interesting to note that for both plants A and C, all workers interviewed for three years reported at least one task that was performed for all three years. Results of this data compiled for Plants A and C are listed in Appendix C. The minimum and maximum number of tasks reported ranged from two to four tasks for Plant A, and one to three tasks for Plant C, and the mean for both plants was two. Again it should be noted that making the task classifications more generic might increase the number of task matches for three years.

The results of the task matches independent of frequency helped show that the frequency of reporting duties can change our results. This could be attributed to one of two reasons, first being that the frequencies of duties change over time, and the other being employee error in reporting task frequencies.

4.2 EXPOSURE MONITORING

4.2.1 Exposure Monitoring and Data Analysis

No statistics were performed on the air monitoring data because there was only one worker of the eleven (nine percent) that received exposures that differed by more than 0.25 fibers/cc from the previous sample. Additionally, most workers' exposure monitoring results were consistent with the plant averages for the corresponding job title. The one worker whose exposure exceeded 0.25 fibers/cc, held the job title "Special Products." Additionally, this worker's exposure exceeded the plant average for this job title by 0.68 fibers/cc.

An evaluation of the tasks that were performed by each worker whose exposure monitoring results came close (difference of 0.2 fibers/cc or more) to the 0.25 fibers/cc difference was performed. Three workers' data met these criteria. The individual mentioned above, another special products worker, and a shipper.

The second special products worker spent the day making RCF modules (0.23 fibers/cc TWA) compared to cutting RCF material with a knife and saw (0.03 fibers/cc TWA) during the previous sampling period. These differences in job tasks are minor, and the documentation is not available to explain the increase in exposure. However, as the nature of the special products worker's tasks changes from day to day, exposures can also change dramatically depending upon what the worker is doing that particular day.

Documentation for the third worker (a shipper) indicated that he spent one-half of the day working with alumina silica products while loading trucks, and the other half of the day was spent performing paperwork. While loading trucks may seem like a clean job, because of the nature of the product and the fiber counting method, higher than average exposures might be seen. It is interesting to note that his exposure on this day also exceeded the plant average for this job title by

0.16 fibers/cc. Because of the limited documentation available for this worker, the true cause of the worker's above-average exposure is unknown.

Other excursions from the plant average exposures were seen in the shipper and needler job titles, however air-monitoring documentation is not available to adequately evaluate the job tasks that were performed during these times.

CHAPTER 5 – CONCLUSIONS

5.1 Summary of Findings

The CEQ data was useful in evaluating whether job tasks change over time. Each of the three separate situations evaluated showed statistically significant results (in 26 out of 32 cases, p was <0.0001). Underlying reasons for this are possibly related to the fact that several tasks are only performed for a short period of time, workers rotate and fill in for other employees on occasion, or incomplete reporting by the employees due to recall bias. When evaluating the task matches independent of frequency reported, we see that the frequency of reporting tasks can increase the number of task matches between interview years.

Air monitoring data showed that exposures remain relatively constant, despite the associated changes in job tasks. This could be a result of the limitations of NIOSH method 7400, or simply the fact that the changes that occur to the job tasks are minor when compared to the routine tasks that are performed within a particular job title. Also important to note is that the data evaluated was representative of average job title exposures for the individual plants.

5.2 Limitations

During this study, a number of limitations were discovered and are outlined below.

5.2.1 Current Employee Questionnaire Data

Data was not available for each year for all of the plants, so changes or consistencies that occurred from year to year may be masked. Also, one of the CEQ questions asks the employee if their job has changed in the last year. Since interviews are not conducted from year to year, this question may not provide the answer the study is hoping to attain.

Since this was an open-ended questionnaire, individual workers may each respond differently to the same question, even though they may be performing the same tasks.

Individual variability is an integral part of this type of questionnaire, as unsolicited responses are obtained from individual workers. The workers' personalities may influence their responses. For example, one worker may thoroughly describe every small task they perform, while another may simply provide a general overview of the tasks. Additionally, the responses may be influenced by the worker's personal life. For example, at one plant it was mentioned that the workers' attitudes had changed since the institution of a union. Also, if there are personal or work-related stresses an individual is experiencing, they might not be able to concentrate on answering the questionnaire and just want to complete it as quickly as possible.

5.2.2 Interviewer Bias

The data were collected by a number of different interviewers, so interviewer bias may have a role in the accuracy of the responses. Each interviewer might interpret what is said differently or promote a better interchange with the worker, as documentation on the CEQs varied from interviewer to interviewer.

5.2.3 Recall Bias

As the CEQ relies on the ability of the worker to recall specific information, the CEQ data may also incorporate a recall bias.

5.2.4 Air Monitoring Data

Air monitoring data was not available for all employees for all years. Currently, ten percent of the workers are sampled each quarter and each job title is monitored annually. Ideally, sequential monitoring year data for the workers is needed to evaluate changes in exposure along with the associated changes in job tasks.

5.2.5 Analysis Method Limitations

The NIOSH method which is used for counting fibers has an overall precision of 0.115 to 0.13 with a limit of detection of < 0.01 fibers/cc (NIOSH, 1994). However the method documentation does alert the user that other airborne fibers may interfere with the results since all airborne fibers that meet the counting criteria are counted.

5.3 Areas for Further Research

During this research it was evident that several areas should be evaluated further. These areas are listed below.

5.3.1 Enlarge the Task Groupings

Enlarge the consolidated task lists by grouping the tasks into more generic categories and then evaluate to determine if grouped tasks change over time.

5.3.2 Combine Daily and Additional Daily Task Frequencies

Combining daily and additional daily task frequencies in future analyses might eliminate the problem of having tasks reported as daily one year, and as additional daily the next year.

5.3.3 Use Standardized Task Listings

Revise the previously identified standardized list of tasks grouped by job title (Byrd, 1990) to allow refinement of the CEQ and eliminate some of the inter-individual variability in reporting tasks. The job of task classification is a large one, and is subject to interpretation. Also, individual plants may perform specific processes that are termed by something other than a conventional name. The use of the standardized list of tasks would help simplify this process, and perhaps even eliminate the job of task consolidation step.

5.3.4 Evaluate by Job Title to Incorporate Additional Employee Interviews

Evaluate the same data, looking at specific job titles to see if tasks change over time. In this thesis, individual workers within a specific job title were evaluated. It was believed that consistency in reporting among the same individuals, tracked year after year, would provide better agreement than by simply looking at all the workers within a job title, comparing worker number one with worker number two. However, we expect that workers within a specific job title are generally performing the same tasks over time, so looking at individual workers may not change the significance of the results. The additional number of interviews this would incorporate should increase the power of our statistical tests.

5.3.5 Evaluate Shift Differences

Evaluation of whether tasks change over time by job title and shift worked. Specific work shifts were not evaluated; all workers holding the same job title were grouped together. This approach could give the indication that tasks change over time, when in actuality the tasks may be different based upon the shift they are worked. For example, worker number one might perform specific tasks during the daytime that are production related (operate furnace), while worker number two on another shift might perform tasks that are associated with preparation for the next days work (change/build needle boards).

5.3.6 Review the Current Air Sampling Protocol

A review of the current air sampling protocol should be conducted to ensure appropriate quantification of worker exposures during full-period and peak exposure times is being performed. Additionally, an evaluation to determine if these changes in job tasks affect the short term and time weighted average exposures is needed.

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Appendix A

Current Employee Questionnaire Documentation and Specifications

Refractory Ceramic Fibers

Current Employee Interview

"Hello. My name is ______________________________. I am from the University of Cincinnati. We have been asked to conduct a health study in this facility. I am part of the same group that asked you about all the jobs that you have held and tests your breathing yearly.

I would like to talk with you for a few minutes about the different duties in your job. Your answers will be kept confidential by the University of Cincinnati. Please go back to your work, if necessary; I have plenty of time."

1. What is your name? ____.
2. What is your job title? ____.
3. Excluding breaks or lunch time, tell me each of the different tasks you do as part of this job each day?
4. How many hours per day do you spend performing each of these tasks?
5. What personal protective equipment is used when performing each of these tasks?

ENTER RESPONSE IN SPACE BELOW BY TASK; REPEAT QUESTIONS 4 AND 5 FOR EACH TASK IN QUESTION 3.

TASKS	# HOURS	PPE USED

6. Are there any additional maintenance or cleanup tasks which you do each day?

If Yes: What are they?

How many hours per day do you spend performing each task?

What personal protective equipment is used when performing each of these tasks?

ASK BOTH QUESTIONS FOR EACH TASK LISTED BELOW.

TASKS	# HOURS	PPE USED

7. Are there any additional tasks (maintenance, cleanup or other) which you do at least once per week or once per month? _____Yes _____No

If Yes: What are they?

How many hours are spent performing each task? Is that per week or per month?

What personal protective equipment is worn when performing each of these tasks?

ENTER TIME AND UNITS BELOW; ASK BOTH QUESTIONS FOR EACH TASK LISTED BELOW.

TASKS	HRS/WEEK OR MONTH	PPE USED

8. Do you do any other tasks less frequently which expose you to dust or chemicals? _____Yes _____No _____Unknown

If Yes: What are they?

How many times did you do ____(task)_____over the last year?

How many total hours were spent doing _____(task)____over the last year?

To what were you exposed while performing this task?

What personal protective equipment was worn while performing each task?

ENTER INFORMATION BELOW FOR EACH TASK.

TASKS	# TIMES	# HOURS	EXPOSURE	PPE USED

9. Has your job title changed in the last year? _____Yes _____No

If Yes: What was your previous job title(s)? ____

(If Yes, continue on to Questions 10 and 11).

10. Does your former job title still exist at this facility? _____Yes _____No

11. Is your new job title a new activity at this facility? _____Yes _____No

Current Employee Questionnaire

Documentation and Specifications

Documentation

This form was devised to document job tasks and duties within job title or assignment. One question will also relate employee perception of exposure to dusts and chemicals to specific tasks done on a less-than-monthly basis.

Specifications

The interviewer starts by an introduction of himself/herself and the reason for conducting the interview.

Questions 1 and 2, "What is your name? What is your job title?" queries the respondent for his/her name and job title. This information will be cross-referenced with occupational history questionnaire, past exposure records, and potential current or future sampling records.

Question 3, "Excluding breaks or lunch time, tell me each of the different tasks you do as part of this job each day.;" ask for the job tasks of the employee, and what the person does during the work day.

The interviewer records the various tasks and the estimated percentage of time spent at each task. The personal protection used during the task should be recorded. Type of respirator (paper mask, half-face, etc.). Also record eye protection (glasses, goggles), and protective clothing worn, e.g. work suit.

Question 4, 'How many hours per day do you spend performing each of these tasks?" Repeat the tasks listed in Question 3 and record time in terms of hours per day. The response is entered for each task listed.

Question 5, "What personal protective equipment is used when performing each of these tasks?" Personal protective equipment (PPE) used during each task is recorded in detail.

Question 6, "Are there any additional maintenance or clean-up tasks which you do each day?" This questions clean up or maintenance tasks which are performed on a daily basis. Response should be yes or no; if yes, probe, "What are they?" The response of task and hours spent on each are probed and recorded. Personal protective equipment used during this task(s) is recorded similar to Question 5.

Question 7, "Are there any additional tasks (maintenance, clean-up, or other) which you do at least once per week or once per month?" This questions clean-up, maintenance, or other tasks, which are less routine but performed on a weekly or monthly basis. Response should be yes or no; if yes, probe, "What are they?" The response of tasks and hours spent on each are probed and recorded. Also probed is the question, "Is that task performed per week or per month?" The frequency of the duty is recorded verbatim. Personal protective equipment used during this task(s) is recorded similar to Question 5.

Question 8, "Do you do any other tasks less frequently which expose you to dust or chemicals?" This question probes the infrequent tasks performed on a less-than-monthly basis. If the response is "yes," the interviewer probes, "What are they? How many times did you do __(task)__ over the past year? How many total hours were spent doing this task?" The responses to these questions are entered in the spaces provided. Use of personal protective equipment is queried by asking, "What personal protective equipment was worn while performing each task?" The information on what was worn as related by the worker is recorded verbatim.

Question 9, "Has your job title changed in the last year?" This queries to determine if the employee has changed jobs within the last year. If the response is "yes," then the interviewer probes, "What was your previous job title(s)?" The response is entered in the spaces provided, and the interviewer continues on with Questions 10 and 11. If the response to Question 9 is "no," then the interview is concluded.

Question 10, "Does your former job title still exist at this facility?" The appropriate yes or no blank is checked.

Question 11, "Is your new job title a new activity at this facility?" The appropriate yes or no blank is checked.

Appendix B

Task Classifications

Plant A
Task Classifications

Clean-up
Clean-up
Clean-up shop
Vacuum machine
Vacuum off machine
Sweep floor
Sweep machine with brush
Sweep area
Sweep floor after plant blowdown
End of shift clean-up (brush)
Sweep work area
Clean

Maintain/clean pit
Go into pit and clean
Shovel out pit
Clean cord pit/dust collector
Rerodding burned out product

Clean with chemicals
Clean machine with solvents
Plant shutdown clean machines with solvents

Administrative
Paperwork
Job assignments
Safety coordinator
Coordinates operations
Reporting/paperwork
Plant walkthrough
Clean office

Operate carding machine
Run card machine
Monitor material from card
Adjust carding machine
Remove finished materials*

Operate tape loom
Operate loom
Set up tape loom
Monitor tape loom

Machine work
Run all machines

Work in warehouse
Search warehouse for matls
Warehouse
Helps material handler
Move boxes to storage racks

Work periodically at Fibermax
Work periodically at Fibermax

Clean with airhose
Plant blowdown
Clean dust collector
Blowdown machine
Card machine clean-up
Blow off rolls
Blow down machine
Airhose (blow dust into collector)
Blow machine down with airhose
Clean under rope machine

Drive equipment
Drive fork truck
Drive truck
Drive jitney
Drive gittney

Welding
Fabricate parts (welding)

Oversee blending system
Blend RCF with rayon
Load fiber into hoppers*
Control blender
Feed matl into blending sys

General maintenance
General maintenance
Install new equipment

Operate braider
Wind yarn off machine
Set up material*
Insert yarn into braider
Feed spools into braider
Run braider
Feed yarn into machine
Monitor machine*

Package product
Box finished product
Remove/box finished product
Box material
Stack and box
Make cartons and label
Pack boxes as machine runs
Weigh boxes/tape
Package rope
Make boxes
Box die cut parts
Label boxes
Remove/box materials

Quality control checks
Quality control sampling
Take samples (QC)
Quality control checks
Quality control

Repair/maintain machinery
Maintain machinery
Repair machines
Check and repair machines
Rebuild machines
Card maintenance
Change belt
Maintenance
Maintain machine
Oil machine
Put oil in machines
Grease machines

Run Former
Run former
Remove cheeses from mach

Wicking
Mix ends of rope wicking
Make rope with wicking
Load machine with wicking
Lay rope

Operate spinner
Load cones on machine
Spin
Gather materials*
Run machines*

Unload/load trucks
Unload trailers

Operate die presses
Operate die cut
Work in XPE
Lift*
Load machine*
Handle rolls (on/off)
Operate XPE die
Remove finished rolls
Load rolls of paper onto mach
Work with heated materials*
Run laminating machine

* Classifications guided by job title

Plant B
Task Classifications

Clean-up
Sweep floors
Sweep work area
General clean-up
Housekeeping
Sweep work area
Clean-up
Clean work areas (sweep)
Sweep trailers/docks
Sweep out trucks
Sweep around tilt furnace

Administrative
Paperwork
QC package
Supervise personnel
Supervise employees
Reporting
Inventory
Administrative
Tour plant

Clean filters/baghouses
Clean filters/baghouses
Clean fume bag
Change fume bags outside
Change dust bag
Change filter bags
Empty dust collectors
Clean dust collector
Clean collectors
Tilt HAS baghouse
Shovel fume hoppers
Empty fume hoppers

Operate ball mill
Operate ball mill

Fill/empty hoppers
Empty hoppers
Empty shot chute
Dump hoppers
Move product/dump hoppers

Drive equipment
Drive forklift
Drive bobcat
Operate bobcat
Run crane on tilt furnace
Move raw materials
Supply workers with raw materials
Deliveries into plant
Service/organize/supply

Vacuum cast board finishing
Cut board
Cut boards
Make boards (cut)*
Sand boards
Run board machine
Operate saws
Sanding boards
Cut boards with saw
Operate board machine
Saw boards
Sand

Clean with airhose
Clean with airhose
Plant blowdown with airhose
Blow off machines
Blow out forklifts
Plant blowdown
Clean around needler
Clean around pots
Clean around furnace

Trouble shoot problems
Trouble shoot problems
Trouble shoot problem ops
Check for trouble as needed
Help maintenance

Relieve other employees
Relieve needler/furnace
Relieve/assist as needed
Utility relief
Relieve other employees

Furnace (non routine op)
Chip out orifices
Rodding out
Adj bottom plate on spinner
Change spinners
Change electrodes
Replace electrodes
Pickup bad electrodes

Set up/monitor pot
Spread mix on pot
Set up pot
Cover pot
Set up/change pot
Chip out pot
Test runs - pilot pot
Rebuild pots
Put ziron in hopper

Change/build needle boards
Needler adjustments
Build/change needle board
Operate needler
Change needle valve
Change needle boards
Operate needler
Stock cabinet with needles
Make boards*
Breakdown spun needler

Vacuum cast operation

Make mixes for board
Vacuum cast operation
Strip rack-remove boards from cast
Make block
Make mix on vacuum cast
Vacuum cast
Make mixes*
Bleach tanks

Operate furnace

Monitor furnance
Monitor gauges
Operate furnace
Maintain furnaces
Turn around furnances
Operate SEF1, tilt, spun furnaces
Add mains to tilt
Assist furnace op A
Add mains and spouts

Special products manufacturing

Operate folding machine
Make modules
Operate pinning machine
Pinning operator
Folding operator

Make cements, LDS & package

Fill pail with cement
Operate cement mixer
Make cements
Fill pail with lds moldable
Lds caulking-make tubes
Operate lds mixer
Package tubes
Lds moldable
Moist pack
Variform
Top coat M

Chop and Bag

Operate bagger
Scrap salvage

Service forklift

Service forklift

Move/arrange product

Move/arrange product
Arrange product
Deliver/receive product

Load/unload product

Load/unload finished product
Unloading materials
Load trailer
Load truck
Open rail cars

Change blocks

Change blocks

Load/unload oven

Load/unload oven
Load oven with forklift

Package product

Package product
Blanket line - box product
Tape boxes
Make boxes

Cut/slit/pack

Cut/slit/pack

* Classifications guided by job title

Plant C
Task Classifications

Clean-up
Sweep shop
Clean shop
Sweep floor
Clean around tumbler/sweep
Sweep shipping area
Sweep work area
Sweep/dust work area
Sweep
Clean-up
Clean-up machines
Sweep floors
Sweeping
Sweep up the area
Clean up control room
Clean up tumbler
General cleaning
General clean (dust/sweep)

Maintain/clean pit
Maintain the pit
Clean out pit
Sweep/shovel pit
Shovel out pit drain
Pit pouring

Get orders ready
Prepare orders
Shrink wrap bales
Shrink wrap boxes
Pull small orders

Fill process oil
Fill process oil tank
Fill mister oiler & neeler
Fill oil tank
Clean process oil nozzle

Sewing
Operate sewing machine

General maintenance
Oversee maintenance
Work on air compressor
Work on unloading system
Work on oven
Work on tumbler
Air compressor maintenance
Work on broken equipment
Make general repairs

Plumbing
Plumbing
Operate presses
Operate compression machine
Operate press
Operate press machine
Run press

Operate mach equipment
Drill press
Millling machine
Grinder
Lathing
Run machine shop
Grinding
Change lathe coolant

Welding
Welding

Clean/treat water system
Clean water system
Acidize water system

Mechanical work
Change motors
Mechanical work
Replace motors

Add/repair electronic equip
Wire electronic equipment
Make repairs/additions
Motor and light replacement
Repair electronics
Make connections

Blanket line maintenance
Maintenance on line
Spot maintenance on the line
Line maintenance
Line/plant maintenance
Take care of production line

Clean with airhose
Dust (blowdown)
Clean bandsaw
Clean-up deck (airhose)
Blowdown furnace
Clean towers and transformer
Blowdown
Clean spinner deck
Compressed air blowdown on spinner deck

General plant clean-up
Major clean-up
Through cleaning

Drive equipment
Drive forklift
Operate silica truck
Pick up scrap with tractor
Operate forklift
Operate tractor
Move trailers away from dock
Move trailers

Load/unload product
Un/load product
Un/box material RCF
Empty rail car

Package product
Box blanket
Roll blanket
Bag fiber
Bale scraps
Measure material
Stack material
Make boxes
Bale
Assembly
Special products package
Work EOL/warehouse
Fill in for EOL
Work EOL
End of line

Make moldable
Make moldable
Work in moldables

Set up/maintain pot
Chip out pot
Chip out pot with jackhammer
Cover the pot with sand
Jackhammer out pots
Jackhammer pots
Chip out furnace

Operate/run hammer mill
Hammer mill fiber-moldable
Operate needler
Run needler
Monitor/adjust blanket
Fill in as needler (mach tndr)
Monitor settling chamber

Change/build needle boards
Change needle boards
Build/brkdown needle board
Insert new needles
Change needles

Furnace maintenance
Throw back batch pot
Maintain furnace
Fire furnace off with torch
Fire off
Shut down*
tar
tar bake oven

Glue modules
Glue
Glue modules
Help make glue
Clean glue machine
Make glue

Dump recyclable materials
Dump dumpsters
Dump sand
Dump scrap recycle
Empty dumpster

Change filters
Change filter on silo
Change filter on unloading sys
Change filters in air handlers

Spinner maintenance
Work on spinner cart
Clean orifice
Spinner card maintenance
Check spinner
Spinner deck
Work on silo, furnace deck
Clean out chamber
Clean chamber

Operate band saw
Operate band saw
Fill in for band saw operator

Office cleaning
Mop offices
Sweep offices
Clean offices
Vacuum
Change trash can liner
Clean windows
Wax desks
Dust
Wax floor

Move/arrange product
Arrange warehouse
Move pallets
Rearrange warehouse
Move material to EOL
Pick up loose pallets
Move boxes
Fill in at warehouse
Move pallets/boxes
Supply material at EOL

Clean bird cage
Clean bird cage

Maintain forklift
Check forklift
Maintain fork truck

Shutdown duties-various
General maint in shutdown
Maint H20 sys in shutdown

Administrative
Paperwork
Oversee line
Office duties
Call truck lines in
Record material weight

Monitor/Operate furnace
Monitor furnace
Fill furnace with silica sand
Measure melt depths
Tend furnace
Keep mix bins full
Set up batch*
Change out flow bins (sand)
Take pour rate samples
Log readings*
Monitor gauges*
Check furnace/moldable
Control room*
Work furnace
Run console*
Change electrodes
Replace electrodes
Change stopper rods
Check product*
Check pour rate
Run machine*
Check furnace

Special products manufacture
Special products fiber roll
Make modules
Operate loop fold
Operate fold back machine
Make instuff
Make/cut strips
Operate loop machine
Make foil back
Special products-module bldg
Work modules
Build modules

Add materials
Send sand to furnace
Supply batch
Put recycle in flow bins
Take to silo and add silica
Tighten gate
Open tops of bins/put lids on
Fill bins with raw materials
Check bins for cracks

* Classifications guided by job title

Appendix C

Task Data For Plants A and C

Plant A Job Title & Matches

3 Matches – everyone that was interviewed for three years had at least one match for the three-year timeframe.

Worker #	Job Title	Tasks Performed
1	Maintenance Technician	Repair/maintain machinery General maintenance no
4	Foreman/Shift Supervisor	Administrative no
5	Card Operator	Oversee blending system Maintain/clean pit no
6	Card Operator	Quality control checks Cleanup Clean with air hose no
16	Die Stop Operator	Operate die presses no

2 Matches –

Worker #	Job Title	Tasks Performed
1	Maintenance Technician	Cleanup
2	Maintenance Technician	Repair/maintain machinery no
3	Electrician	Repair/maintain machinery no
4	Foreman/Shift Supervisor	Quality control checks
5	Card Operator	Operate carding machine Cleanup
6	Card Operator	Operate carding machine Oversee blending system Package product

Worker #	Job Title	Tasks Performed
7	Machine Operator	Operate spinner Package product Cleanup no
8	Technician	Operate die presses Cleanup Clean with air hose no
9	Technician	no
10	Technician	Operate die presses no
11	Shipping/Receiving Clerk	Package product Drive equipment Unload/load trucks no
12	Braider Operator	Package product Operate braider Clean with air hose Cleanup Clean with chemicals no
13	Braider Operator	Operate braider no
14	Rope Layer Machine Operator	Wicking no
15	Tapeloom Loom Operator	Operate tape loom Cleanup Repair/maintain machinery
16	XPE Die Stop Operator	Quality control checks Drive equipment Cleanup Work in warehouse

One Task – Not reported in subsequent years.

Worker #	Job Title	Tasks Performed
1	Maintenance Technician	Welding Clean with chemicals
2	Maintenance Technician	Cleanup
3	Electrician	General maintenance Work periodically at Fibermax
4	Foreman/Shift Supervisor	Cleanup Work in warehouse Drive equipment Clean with air hose
5	Card Operator	Package product Clean with air hose Maintain/repair machinery
6	Card Operator	Maintain/clean pit Run former Repair/maintain machinery Wicking
7	Machine Operator	Clean with air hose Repair/maintain machinery
8	Technician	Operate braider Operate spinner
9	Technician	Quality control checks Machine work Clean with air hose Package product Operate braider Operate die presses Cleanup Repair/maintain machinery
10	Technician	Operate die presses Administrative Cleanup Maintain/clean pit

Worker #	Job Title	Tasks Performed
11	Shipping/Receiving Clerk	Operate die presses Administrative Cleanup Maintain/clean pit
12	Braider Operator	Work in warehouse Repair/maintain machinery
13	Braider Operator	Repair/maintain machinery Cleanup Clean with air hose
14	Rope Layer Machine Operator	Package product Maintain/clean pit Clean with air hose
15	Tapeloom Loom Operator	Clean with air hose
16	XPE Die Stop Operator	Package product Cleanup

Plant C Job Title & Matches

3 Matches – everyone that was interviewed for three years had at least one match for the three-year timeframe.

Worker #	Job Title	Tasks Performed
5	Machinist	Operate machine equipment Cleanup no
9	Warehouseman	Load/unload product Cleanup no
10	Warehouseman	Load/unload product Cleanup no
14	Special Products	Special products manufacture Cleanup
15	Special Products	Operate bandsaw Cleanup
16	Special Products	Sewing Cleanup Glue modules
17	Utility Man	Operate bandsaw Special products manufacture Cleanup
19	Furnace Tender	Monitor/operate furnace Clean with airhose
20	Furnace Tender	Monitor/operate furnace Special products manufacture
21	Batch Mixing Crew Leader	Add materials Cleanup

Worker #	Job Title	Tasks Performed
23	Machine Tender/Crew Leader	Monitor/operate furnace Clean with airhose
24	Machine Tender/Crew Leader	Monitor/operate furnace
27	Needler	Operate needler Cleanup Fill process oil

2 Matches –

Worker #	Job Title	Tasks Performed
9	Warehouseman	Drive equipment
10	Warehouseman	Move/arrange product
14	Special Products	Glue modules General plant cleanup no
15	Special Products	Sewing Glue modules no
16	Special Products	Operate bandsaw Operate presses
17	Utility Man	Operate presses Glue modules no
19	Furnace Tender	Setup/maintain pot Furnace maintenance Shutdown duties–various
20	Furnace Tender	Cleanup no
21	Batch Mixing Crew Leader	Drive equipment Make moldable no

Worker #	Job Title	Tasks Performed
23	Machine Tender/Crew Leader	Cleanup Spinner maintenance
24	Machine Tender/Crew Leader	Package product Furnace maintenance Blanket line maintenance Cleanup Spinner maintenance no
27	Needler	no